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Metal oxides as electrode materials for electrochemical capacitors

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Metal oxides as electrode materials for electrochemical capacitors

A thesis submitted in fulfilment of the
requirements for the award of the degree

Master of Engineering - Research

From

University of Wollongong

By

Zhuo Jin Lao, B. Eng

Institute for Superconducting and Electronic Materials

Faculty of Engineering

2006

Certification

I, Zhuo Jin Lao, declare that this thesis, submitted in fulfilment of the requirements for the award of Master of Engineering - Research, at the Institute for Superconducting and Electronic Materials, Faculty of Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Zhuo Jin Lao

25 January 2006

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Abstract

Electrochemical capacitors are becoming attractive energy storage devices and fill the gap between batteries and conventional capacitors because they have higher energy density than conventional dielectric capacitors and have higher power density and a longer cycling life than batteries. In this study, transition metal oxides, such as Co_3O_4 , NiO , V_2O_5 and MnO_2 , have been successfully synthesized by different chemical-based solution methods. Their physical properties were characterized by X-ray diffraction, SEM, and BET analysis. The as-prepared Co_3O_4 , NiO , V_2O_5 and MnO_2 were investigated as electrode materials for electrochemical capacitors and demonstrated very high specific capacitances, which were 168 F/g, 203 F/g, 262 F/g, and 406 F/g, respectively. This may be due to their large surface areas (Co_3O_4 (82 m^2/g), NiO (90 m^2/g), V_2O_5 (41 m^2/g) and MnO_2 (269 m^2/g)) and pseudocapacitive behaviour. Compared with expensive RuO_2 , which has been used extensively as electrode material for electrochemical capacitors, the as-prepared Co_3O_4 , NiO , V_2O_5 , and MnO_2 are much cheaper. This makes them very promising candidates as electrode materials for electrochemical capacitors.